

WHAT IS CLAIMED IS:

- 1 1. A dry forming apparatus comprising:
2 a mold-transfer mechanism for transferring a mold containing a die and
3 punch units at least between a powder supply stage, a pressing stage, and a
4 formed-product removing stage;
5 a pressing driving mechanism for driving the punch units for pressing in
6 the pressing stage;
7 a connecting mechanism for connecting punch units to the pressing driving
8 mechanism when the mold is transferred to the pressing stage, and for releasing
9 the connection of the punch units; and
10 a unit holding mechanism for holding the punch units while the units are
11 transferred to the next stage.
- 1 2. A dry forming apparatus according to claim 1, further comprising
2 in the powder supply stage:
3 a charging driving mechanism for driving the punch units to form a space
4 to be filled with powder in the powder supply stage;
5 a connecting mechanism for connecting the punch units to the charging
6 driving mechanism when the mold is transferred to the powder supply stage, and
7 for releasing the connection of the punch units when the mold is transferred to the
8 next stage; and
9 a unit holding mechanism for holding the punch units while the mold is
10 transferred to the next stage.
- 1 3. A dry forming apparatus according to claim 1, further comprising
2 in the formed-product removing stage:
3 a taking-out mechanism for driving the punch units in the formed-product
4 removing stage, to take out the formed product;

5 a connecting mechanism for connecting the punch units to the taking-out
6 driving mechanism when the mold is transferred to the formed-product removing
7 stage, and for releasing the connection of the punch units when the mold is
8 transferred to the next stage; and
9 a unit holding mechanism for holding the punch units while the mold is
10 transferred to the next stage.

1 4. A dry forming apparatus according to claim 1, wherein the
2 connecting mechanism is provided for each of the pressing driving mechanism, the
3 charging driving mechanism, and the taking-out driving mechanism; and
4 whereby the punch units are driven by the pressing driving
5 mechanism, the charging driving mechanism, and the taking-out driving
6 mechanism via the connecting mechanism.

1 5. A dry forming apparatus according to claim 1, wherein the
2 connecting mechanism comprises:
3 clamp bodies fixed to each of the pressing driving mechanism, the charging
4 driving mechanism, and the taking-out driving mechanism;
5 sliding claws movably supported on each of the clamp bodies; and
6 an advancing-receding driving mechanism which advances or recedes each
7 of the sliding claws between a clamping position at which the punch units are
8 clamped and an unclamping position at which the clamping is released.

1 6. A dry forming apparatus according to claim 1, further comprising:
2 punch units and a die;
3 wherein the punch units each include an upper punch unit including
4 at least first and second upper-punches, and a lower punch unit including at least
5 first and second lower-punches, the upper and lower punch units being opposed to
6 each other across the die, and the pressing driving mechanism includes driving

7 shafts connected to the first and second upper-punches and the first and second
8 lower-punches, respectively, and actuators which independently drive the driving
9 shafts.

1 7. A dry forming apparatus according to claim 2, further comprising:
2 a lower punch unit including at least first and second lower-
3 punches; and
4 the charging driving mechanism and the taking-out driving
5 mechanism each including driving shafts connected to the first and second lower-
6 punches and actuators which independently drive the driving shafts.

1 8. A dry forming apparatus according to claim 6, wherein each
2 driving shaft includes a strut and a ball screws screwed into the strut, each punch
3 unit being connected to the strut, and the actuator being connected to the ball
4 screw.

1 9. A dry forming apparatus according to claim 6, wherein each
2 actuator includes a servomotor and a timing belt, the timing belt positioned so that
3 rotation of the servomotor is transmitted to the ball screw via the timing belt.

1 10. A dry forming apparatus according to claim 6, wherein at least the
2 driving shafts for the first and second upper punches each include a coaxial multi-
3 shaft structure including an inner cylinder and an outer cylinder, the inner cylinder
4 inserted into the outer cylinder relatively movably in the axial direction, wherein
5 the first and second upper-punches can be independently driven by the relative
6 movement of the outer and inner cylinders.

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1 11. A dry forming apparatus according to claim 1, wherein the
2 mold-transfer mechanism includes a rotary table, the mold being transferred to any
3 one of the stages by rotation of the rotary table.

1 12. A dry forming apparatus according to claim 1, wherein the
2 mold-transfer mechanism includes a linear table, the mold being transferred to any
3 one of the stages by linear movement of the linear table.

1 13. A dry forming apparatus according to claim 1, wherein the
2 unit-holding mechanism is configured and arranged to hold the punch units, to
3 cooperate with the clamp-releasing operation when the connecting mechanism
4 releases the clamping of the punch units, and to cooperate with the clamping
5 operation when the connecting mechanism clamps the punch units to release the
6 holding of the punch units.

1 14. A dry forming apparatus according to claim 1, further comprising:
2 a powder charging mechanism in the powder supply stage for charging a
3 powdery raw material into the space to be dry-formed of the die; and
4 a formed-product taking-out mechanism in the formed-product removing
5 stage for taking out a press-formed product from the mold.

1 15. A dry forming apparatus according to claim 1, further comprising:
2 a machining stage between the pressing stage and the formed-product
3 removing stage for machining a pressing-formed product.

1 16. A dry forming apparatus according to claim 1, further comprising:
2 a cleaning stage next to the formed-product removing stage for removing
3 powder adhering to the die and the punch units.

1 17. A method of powder press forming to produce a formed-product in
2 which a mold containing a die and punch units is transferred at least to a powder
3 supply stage, a pressing stage, and a formed-product removing stage in that order,
4 comprising the steps of:
5 in the powder supply stage,
6 charging powder into the mold, and
7 transferring the mold to the pressing stage while the mold is held;
8 in the pressing stage,
9 positioning the mold, the mold being fixedly located and interlocked
10 with a pressing driving unit, and releasing the punch units,
11 pressing by driving the mold with the pressing driving unit to press
12 the powder, and
13 transferring the mold, including
14 releasing the fixed positioning of the mold,
15 releasing the pressing driving unit, and
16 holding and transferring the mold to the formed-product
17 removing stage; and
18 taking out the formed product from the die in the formed-product removing
19 stage.

1 18. A method of dry forming according to claim 17, further including
2 the steps of:
3 in the powder supply stage,
4 positioning and fixedly locating the mold, the mold being connected
5 to a charging driving mechanism, and releasing the punch units,
6 forming a charge space, including driving the mold by the charging
7 driving mechanism to form the charge space to be filled with powder,
8 charging the powder into the mold,
9 transferring the mold, including

10 releasing the fixed positioning of the mold,
11 releasing the mold from the charging driving mechanism,
12 and
13 transferring the mold to the pressing stage while holding the
14 mold.

1 19. A method dry forming apparatus according to claim 17, further
2 comprising the steps of:
3 in the formed-product removing stage,
4 positioning the mold including,
5 fixedly locating the mold,
6 connecting the mold to a taking-out driving mechanism, and
7 releasing the punch units,
8 taking out the formed product, including driving the mold by the
9 taking-out driving mechanism to take out the formed product from the die, and
10 transferring the mold, including
11 releasing the fixed location of the mold,
12 releasing the mold from the taking-out driving mechanism,
13 and
14 transferring the mold to the next stage.

1 20. A dry forming apparatus according to claim 7, wherein each
2 driving shaft includes a strut and a ball screws screwed into the strut, each punch
3 unit being connected to the strut, and the actuator being connected to the ball
4 screw.

- 1 21. A dry forming apparatus according to claim 7, wherein each
2 actuator includes a servomotor and a timing belt, the timing belt positioned so that
3 rotation of the servomotor is transmitted to the ball screw via the timing belt.

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